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A Cost-Effective Multi-Terrain Autonomous Vehicle for Land Mine Detection*

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ABSTRACT

This paper describes an innovative and unique autonomous vehicle system being developed at the Lawrence Livermore National Laboratory (LLNL) for land mine detection and neutralization. While much research is being done on probabilistic detection methods, not much consideration has been given to safe and cost-effective sensor deployment.

The Spiral Track Autonomous Robot (STAR) system is an automated mechanism which uses left and right-hand Archimedes screws, in contact with the terrain, to propel itself along the terrain. By rotating the screws in one of the different rotation combinations, it is possible to move the vehicle four translational directions and two rotational directions. Unlike conventional four-wheel vehicles, this design has resulted in a mobile vehicle with a low center-of-gravity (cg) capable of traversing multiple terrains at somewhat steeper inclines. The hollow cylindrical screws with outer pitch blades, combined with a lightweight construction, help to give the vehicle enough buoyancy and water displacement for negotiating saturated terrain and streams. Multiple modes of operation include wireless remote control and autonomous computer control. Autonomous operation of the vehicle is accomplished by the on board computer system and control software.

Mounted with the Micropower Impulse Radar (MIR) land mine detection technology developed here at LLNL, the STAR becomes a low cost (as low as $5,000) transport and sensor deployment vehicle. Once positions of land mine ordinances are determined by the MIR package, global positioning system (GPS) coordinates from the onboard GPS receiver are relayed via a wireless data link to a remote intelligence station. When further equipped with CCD cameras and infrared sensors for multi-sensor operation, the STAR becomes a much more versatile and effective land mine detection system. Under autonmous operation the STAR can be pre-programmed with a desired reactionary task (i.e., detonation, marking of location or extraction). Under remote-control operation, the operator can choose the reactionary task with the aid of the data and telepresence afforded by the continuous wireless video feedback.

Tests on phase 1 of the system have proven operation in multiple terrains including mud, water, sand, hard, rocky and soft soils. Current and future work includes a re-designed mechanical frame for multiple sensor fusion and electronics integration.

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